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Improvement of Mathematical Problem Solving Ability Through Problem Based Learning Model In Applied Mathematics Course II In Industrial Engineering Program of Polytechnic of South Aceh

Resky Rusnanda[a,1], Asmaidi[b,2]

[a] *Polytechnic of South Aceh, Merdeka Street, Komplek Reklamasi Pantai, Tapaktuan city, 23751, Indonesia*
[b] *Polytechnic of South Aceh, Merdeka Street, Komplek Reklamasi Pantai, Tapaktuan city, 23751, Indonesia*
[1] *reskyrusnanda@gmail.com;* [2] *asmedmat@gmail.com*

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ABSTRACT

This research is a quantitative research by true experimental design. Research design is random, pre test and post test. Sample is prepared randomly by two group; experiment and control group. Experiment group is prepared by problem based learning with 13 students in this group, while control group is taught by conventional method with 10 students in this group. Tests are applied in data collecting, then analyzed by t-test. Data analysis shows at α = 0,05 there was $t_{count} = 2{,}16$ dan t_{Tabel}= 1,72 atau $t_{count} > t_{Tabel}$. It can be concluded that the increase in mathematical problem solving from experiment group is relatively better than those in control group in Applied mathematics II Course in Industry Technics Study Program, South Aceh Polytechnic.

I. Introduction

A. Background

According to [5] problem-based learning is a learning where students work on authentic issues with the intent of composing their own knowledge, developing inquiry, higher thinking skills, developing self-reliance and self-confidence. According to [3] said that problem-based learning is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills and to acquire essential knowledge and concepts from subject matter.

Based on the definition and characteristics of problem-based learning model, the model is suitable to be applied in the learning process, especially mathematics learning in Applied Mathematics course II. In the curriculum of Industrial Engineering Program of Polytechnic of South Aceh the subject of Applied Mathematics II is taught in the second semester. The teaching material in the applied mathematics course II is differential / derivative. During the courses, researcher found the student difficulties in solving the differential problems. Therefore, it would possibly affirmative when the problem-based learning model applied in teaching courses Applied Mathematics II with the hope of student difficulties to study the material can be minimized.

In the problem-based learning model, the lecturer organized the students in small groups so they can exchange ideas through group interaction, hypothesize, design experiments, investigate, collect data, interpret data, conclude, present, discuss and report dealing with students problem solving skills. Therefore, the researcher is interested in conducting study on the application of problem based learning on Applied Mathematics II courses to improve the problem solving ability of mathematics students of Industrial Engineering Program of Polytechnic of South Aceh.

B. Aims

This study aims to determine the improvement of problem solving skills of students who taught mathematics with problem-based learning model on subjects of Applied Mathematics II in the Industrial Engineering Program Polytechnic of South Aceh.

II. Literauture Review

A. Definition of Problem Solving

Problem is a gap between desire or expectation with the reality that occure. In the context of mathematics learning, the problem is something that the consciously understood by the students to look for the solution but to get the solution not only applying popular default procedure.

According to [10] the problem is the state of a being or event that possibly be replaced in certaint way to gain the desired result. According to [2] that the problem is a situation faced by a person or group of people who must be resolved but do not know what to do to get the solution. Furthermore [2] states the problem arises when there is a goal to be achieved but has not found the means to achieve that goal. According to [9] problem-solving is seen as a process of finding a combination of a number of rules that can be applied in an effort to overcome the new situation. Furthermore, according to [4], the stages of problem solving include, 1) the delivery of ideas, 2) the presentation of known facts, 3) studying the problem, 4) formulating the action plan, and 5) the evaluation.

Based on the above quotation can be concluded that problem solving of mathematics is looking for a solution of the problems encountered and prove the solution by following certain stages that can be applied so that the expected solution can be achieved.

B. Definition of Problem Based Learning

Problem-based learning is a learning that requires the mental activity of students to understand a concept of learning through situations and problems presented at the beginning of learning. The problem presented to students is daily life issue (contextual). This problem-based learning is designed with the aim of helping students develop thinking skills and develop problem-solving skills.

According to [5] problem-based learning is a learning model that also refers to teaching strategies associated with contextual learning. According to [4] states that problem-based learning aims to help students develop thinking skills and problem solving skills.

C. Characteristic of Problem-Based Learning

According to [5] problem-based learning has the following characteristics:

1) Prompting of questions or problems
   Problem-based learning demands the role of lecturers organizing learning around questions and problems other than organizing lessons around certain academic principles or skills. The lecturer shows a complex real-life situation. Students are required to fulfill the tasks assigned by lecturers by connecting various disciplines that they already know.
2) Inter-disciplinary focus
   Although the learning process is aimed at a particular field of science (science, mathematics, or social research), but in solving actual problems students can be directed in the investigation of various fields of science.
3) Authentic Investigation
   Students analyze and define problems, develop hypotheses, forecast, gather information, analyze information, and execute experiments, make inferences and conclude.
4) Product Performance
   Students are required to produce certain products in the form of real works or artifacts and demonstrations that explain or represent the form of problem solving that they find.
5) Assessment/ Collaboration
   Problem-based learning calls for cooperation between students in small groups.

D. Procedure of Problem Based Learning Model

In [5] problem-based learning consists of 5 phases and lecturer's behavior, ie:

Table 1. Phase of Problem-Based Learning Model

Phase	Lecturer's Behavior
Phase-1 Orientation	Lecturers convey the purpose of learning, describe the various important logistical needs and motivate students to engage in problem-solving activities
Phase-2 Organization	Lecturers help students define and organize learning tasks related to the problem
Phase-3 Independent and group investigations	Lecturers encourage students to get the right information, carry out experiments, and seek explanations and solutions
Phase-4 Developing and presenting	Lecturers assist students in planning and preparing appropriate artifacts, such as reports, videotapes, and models and helping them to pass it on to others
Phase-5 Analysis and evaluation	Lecturers help students reflect on their investigations and the processes they use

Based on the above quote, the phase of problem-based learning model is a learning model in which a series of learning activities that emphasize the process of solving problems faced scientifically.

III. Research Method

A. Types and Research Approach

The type of research used in this study is quantitative research. This is due to the purpose of this study, namely to see the difference in the improvement of student learning outcomes taught by the problem-based learning model and students who are taught with conventional learning. Quantitative research can be seen in the use of numbers at the time of data collection, data absorption and appearance of the results [1]. The research approach used is research expriment.

B. Research Design

The research design used in this research is random, pre-test, post-test. In this design there are classes of expriences and control classes, samples are selected randomly and observed twice (pre-test and post-test) ". Before starting the treatment the two groups were given a pre-test to measure the initial condition (O1), then the experimental group was treated (X), while the control group did not. After completion of treatment both groups were given a final test that was post-test (O2). In general, the random model, pre-test-post-test design as follow:

$$\begin{array}{cccccc} \mathbf{E} & & \mathbf{O_1} & \mathbf{X} & \mathbf{O_2} \\ & \mathbf{R} & \multicolumn{3}{c}{\rule{4cm}{1pt}} \\ \mathbf{K} & & \mathbf{O_3} & & \mathbf{O_4} \end{array}$$

Annotation:

E = Experiment class
K = Control class
R = Random
X = Treathmen
O_1 = The initial state of the experimental class
O_3 = The initial state of the control class

C. Population and Sample

The population in this research is all students of Industrial Engineering Program of Polytechnic of South Aceh. The sample in this research is the second semester students of Industrial Engineering Program of Polytechnic of South of Aceh as much as 2 classes.

D. Data Collecting Technique

The data to be used in this research is mathematical problem solving data. These data were collected using test instruments both before treatment (pre-test) and after treatment (post-test). The test for pre test and post test consists of 5 description questions, with the aim to determine how far the students' mathematical problem solving abilities. In conducting the research, the researcher will conduct 5 meetings, 2 meetings to conduct the test in the form of pre-test and post-test, while 3 meetings to do the learning.

E. Data Analysis

The data to be analyzed is data of pre-test and post-test in the form of problem solving test data. The pre-test and post-test scores are based on the following indicators [3]:

1) Students are able to understand the problem (identify the problem), knowing the purpose of the problem and classify preliminary informationand demands of the problem.
2) Students are able to choose a problem solving strategy that will be used in solving the problem, whether students draw sketches / drawings / models, formulas or algorithms to solve problems.
3) Students are able to solve problems correctly, completely, systematically and thoroughly.
4) Students are able to interpret the solution, ie answer what is asked and draw conclusions.

Scoring criteria of mathematical problem solving ability is provided as Table 3 below.

Table 3. Scoring criteria of mathematical problem solving ability

Assessment Points	Score	Rubrics
Ability to understand the problem. Students write down given equation/logic and problems found	0	Write none
	0,5	If only have mistaken information
	1	Write down given logic and problems but has one slight mistake.
	2	Exactly as required.
Ability to plan problem solving. (students write sketches / drawings / models / formulas / algorithms to solve problems)	0	Write none
	0,5	Unsuited sketches/drawing/ formulae, etc
	1	Slightly suited sketches/ drawing/ formulae, etc
	2	Almost suited sketches/ drawing/ formulae, etc.
	3	Exactly as required.
Ability to resolve problems as planned. (students can solve problems from math problems correctly, systematically, completely and thoroughly)	0	Write none
	0,5	Wrong answer.
	1	Tend to the right solution but misscalculate.
	2	Systematically correct but had wrong answer
	3	Exactly as required.
Ability to interpret the solution.	0	No answer
	0,5	Wrong answer and missinterpreted.
	1	Slightly missinterpreted.
	2	Exactly as required.

[3]

The maximum score for a mathematical problem solving test for each item is 10. The score for the whole question 50, because it consists of 5 questions. Maximum score is 100. Based on these guidelines, obtained pre-test score and post-test that will be used to determine the improvement of students' mathematical problem solving skills.

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After collecting research data presented in the table of pre-test scores and post-test students, then the data is processed and analyzed using statistical formulas, as follows:

1) Compare the pre-test and post-test scores to find the gains that occur after the learning in each group calculated by the normalized gain formula [8] ie:

$$g = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}} \qquad (1)$$

2) The value of pre-test and N-Gain of each class will be calculated the average value. According to [6] the average value ($\bar{x}$) is calculated using the formula:

$$\bar{x} = \frac{\sum x_i}{n} \qquad (2)$$

The calculation of the mean value of N-gain is then interpreted by using the following classification.

Table 3. *N-Gain Criteria*

N-Gain	Interpretation
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Mid
$g < 0.3$	Low

[8]

3) For varians (s^2), as [6] can be calculated as:

$$S^2 = \frac{n \Sigma x_i^2 - (\Sigma x_i)^2}{n(n-1)} \qquad (3)$$

4) To determine the standard deviation (s), according to [6] the formula as followed:

$$s = \sqrt{\frac{n \sum x_i^2 - (\sum x_i)^2}{n(n-1)}} \qquad (4)$$

5) Test the normality of data distribution is needed to know whether the data in this study is normal distribution or not. Researchers use the Lilliefors test because this test is used in discrete data that is spreading or not presented in interval form. According to [6], Lilliefors's test steps are:
   a) Calculate the average value and standard deviation.
   b) Arrange data from the smallest to the largest data in the table.
   c) Change the value of x to the value of z by the formula:

$$z = \frac{x - x}{s} \qquad (5)$$

   d) Calculating the z area by using table z that has been attached.
   e) Determine the value of the proportion of data smaller or equal to the data.
   f) Calculate the difference in z with the proportion value.
   g) Determine the maximum area (L_{max}) from the previous step.
   h) Specifies the table area of Lilliefors (L_{table}); $L_{table} = L\alpha\ (n-1)$.
   i) Criterion of normality: if $L_{max} < L_{table}$ then the data is normally distributed.
6) Homogeneity test of variance is useful to know whether the data obtained from this study comes from the same population or not. To test the homogeneity of variance statistics were used as described [6] as follows:

$$F = \frac{Hign\ Variances}{Low\ Variances} \tag{6}$$

By these hypotheses:
$H_0: \sigma_1^{\ 2} = \sigma_2^{\ 2}$ (both varians are homogene)
$H_1: \sigma_1^{\ 2} \neq \sigma_2^{\ 2}$ (both are not homogen)

This test is a two-party test, because it is a study that requires a comparison between two conditions or two populations. Then the test criteria : "H_0 Accepted if $F < F_\alpha$ ($dkn_{highvarians}$-1/$dkn_{lowvarians}$-1)". To test the given hypothesis, according to [6] as follow:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \tag{7}$$

To find the combined variance ($S^2_{combined}$), according to [7] can be measured by:

$$S^2_{gab} = \frac{(n_1-1)s_1^{\ 2} + (n_2-1)s_2^{\ 2}}{n_1+n_2-2} \tag{8}$$

Hypothesis testing using t-test right side to gain score mathematical problem solving ability to know difference of improvement of student's mathematical problem solving ability between control class and experiment class at significant level α = 0,05. The test is average μ_1 and μ_2, the hypothesis pair H_0 and the match is H_1:

H_0: $\mu_1 = \mu_2$ There is no difference in the improvement of students' mathematical problem solving ability using problem-based learning model with improvement of problem solving ability of mathematical student using conventional learning.

H_1: $\mu_1 > \mu_2$ Improving students 'mathematical problem solving skills using problem based learning model is better than improving students' mathematical problem solving abilities using conventional learning.

Because the test used is a right-hand test, the applicable test criterion H_0 is rejected when t > $t_{1-\alpha(n_1+n_2-2)}$ and H_0 is accepted when t have other values, with degrees of indepency dk = $n_1 + n_2 - 2$ and by chance $(1-\alpha)$.If the data is not normally distributed, then the hypothesis will be tested with a non-parametric statistical test. The test used is Mann-Whitney test. According to [7] the Mann Whitney test is used to test the mean differences of the two sample groups mutually independent if one or both groups of samples are not normally distributed.

F. Notasi

g	=	Normalized gain
S_{post}	=	pos-test Score
S_{pre}	=	pre-test Score
S_{maks}	=	Maximum value
$\bar{x}$	=	Average value
x_1	=	pre-test value of experimental class
x_2	=	pre-test value of control class
x_3	=	pos-test value of experimental class
x_4	=	pos-test value of control class
n	=	Data amount
n_1	=	Data amount of experimental class
n_1	=	Data amount of control class
S^2	=	Varians
s	=	Standart deviation
$\sum$	=	Sum notation (Sigma)

IV. Result and Discussion

A. Score Test

The data obtained in this study comes from pre-test and post-test in the course Applied Mathematics II. The mathematical problem solving ability data obtained from the test is presented below.

1) Experiment Class (A)
   Mathematical problem solving skill of pre-test

   55 60 52 65 75 45 70 55 60 50 65 52 55

   Mathematical problem solving skill *of post-test*

   95 75 90 85 80 75 100 85 70 80 90 80 70

2) Control Class (B)

   Mathematical problem solving skill of pre-test

   50 70 52 50 45 60 55 50 62 45

   Mathematical problem solving skill of post-test

   75 80 70 60 60 80 68 65 70 90

B. Data Analysis

Calculation of Average Value ($\bar{x}$), varians (s_i^2), dan standard deviation (s_i) mathematical problem solving abilities on pre-test as follows.

Table 4. Calculating Average, Variance and Standard Deviation Initial Test Score of Mathematical Problem Solving Ability of Student Class of Experiment and Control

No	x_1	x_1^2	x_2	x_2^2
1	55	3025	50	2500
2	60	3600	70	4900
3	52	2704	52	2704
4	65	4225	50	2500
5	75	5625	45	2025
6	45	2025	60	3600
7	70	4900	55	3025
8	55	3025	50	2500
9	60	3600	62	3844
10	50	2500	45	2025
11	65	4225		
12	52	2704		
13	55	3025		
$\sum$	759	45183	536	29623
$\bar{x}$	58,4	3475,6	53,6	2962,3

Annotation:

x_1 = Pre-test score in experiment class

x_2 = Pre-test score in control class

From the calculation result obtained variance value (s_1^2)and standard deviation (s_1)each of the initial tests of the experimental class is 72,423 and 8,51. Variance value (s_2^2) and standart deviation (s_2) pre test control class is 99,266 and 9,96.

1) Normality Test of Preliminary Data

Test the normality of data distribution aim to know whether from each group in this research come from normal distribution population or not. The author uses the Lilliefors Test because the data obtained are not presented in intervals.

Table 5. Test Normality Data distribution Initial Test Score Ability Problem Solving Mathematical Problem Student Class Experiment (A)

x_i	f_i	f_{kum}	z_i	Table z	z_i	S(z_i)	| zi-S(z_i)|
45	1	1	-1,57	0,4418	0,0582	0,077	0,0188
50	1	2	-0,99	0,3389	0,1611	0,154	0,0071
52	2	4	-0,75	0,2734	0,2266	0,308	0,0814
55	3	7	-0,40	0,1554	0,3446	0,538	0,1934
60	2	9	0,19	0,0753	0,5753	0,692	0,1167
65	2	11	0,78	0,2823	0,7823	0,846	0,0637
70	1	12	1,36	0,4131	0,9131	0,923	0,0099
75	1	13	1,95	0,4744	0,9744	1	0,0256

Based on table 5 obtained L_{max} = 0.1934 and Lilliefors tables Range (L_{table}), $L_{table} = L_{0,05}(13-1) = L_{0,05}(12)$ = 0,242. $L_{max} < L_{table}$, are 0.1934 < 0.242; therefore the data is normally distributed.

Table 6. Normality Test Data Distribution Initial Test Score Capability Mathematical Problem Student Control Class (B)

x_i	f_i	f_{kum}	z_i	Table z	z_i	S(z_i)	| zi-S(z_i)|
45	1	1	-0,86	0,3051	0,1949	0,1	0,0949
50	3	4	-0,36	0,1406	0,3594	0,4	0,0406
52	1	5	-0,16	0,0636	0,4364	0,5	0,0636
55	1	7	0,14	0,0557	0,5557	0,7	0,1443
60	1	8	0,64	0,2389	0,7389	0,8	0,0611
62	1	9	0,84	0,2995	0,7995	0,9	0,1005
70	1	10	1,65	0,4545	0,9545	1	0,0455

Based on table 6 obtained L_{max} = 0.1443 and Lilliefors tables Range (L_{table}), $L_{table} = L_{0,05}(n_2-1) = L_{0,05}(9)$ = 0,271. $L_{max} < L_{table}$, are 0.1443 < 0.271; therefore the data is normally distributed. After the distribution of the initial test data of the experimental class and the normal distributed contraction class, it is followed by homogeneity test of initial test variance.

2) Homogeneity Test of Pre Test Variance

The homogeneity test was conducted to test the homogeneity of data variance to be analyzed between the experimental class and the control class. According to [7] the pair of hypotheses to be tested in homogeneity testing are as follows:

$H_0: \sigma_1^2 = \sigma_2^2$ (both homogeneous variance)
$H_1: \sigma_1^2 \neq \sigma_2^2$ (both variance is not homogeneous)

This test is a two-party test, because it is a study that requires a comparison between two conditions or two populations. Testing criteria :"H_0 is accepted when $F < F_\alpha$(dkn$_{highvarians-}$

1/dkn$_{lowvarians-1}$)". Based on the previous calculation, the initial test variance obtained from each group s_1^2 = 72,423 (experimental class variance) and s_2^2 = 99,266 (variance control class). To test the homogeneity of samples used equation as follows:

$$F = \frac{\text{Hign Variances}}{\text{Low Variances}}$$

$$F = \frac{99,266}{72,423}$$

$$F = 1,37$$

F From the distribution table obtained:

F(dkn$_{highvarians-1}$/dkn$_{lowvarians\ -1}$) = $F_{0.05}$ (10-1/13-1) = $F_{0.05}$ (9/12) = 2,80

So F_{count} = 1.37 dan F_{table} = 2,880, it is clear that $F_{count} < F_{table}$ then H_0 is accepted and it can be concluded that the two homogeneous variance for pre-test data.

3) Calculation of N-Gain value from pre-test score and post-test

a) N-Gain scores the problem-solving abilities of experimental class mathematics (A)

0,89 0,38 0,79 0,57 0,20 0,55 1,00 0,67 0,25 0,60 0,71 0,58 0,33

b) N-Gain scores the ability of mathematical problem-solving control classes (B)

0,50 0,33 0,38 0,20 0,27 0,50 0,29 0,30 0,21 0,82

Calculation of the average value $(\bar{x})$ N-Gain scores mathematical problem-solving abilities. N-Gain value of each class is calculated the average value so that the average value of each class as follows.

Table 7. Average N-Gain Score of Mathematical Problem Solving for Students in Class of Experiment (A) and Control Class (B)

No	Experiment Class		Control Class		N-Gain Experiment Class	N-Gain Control Class
	x_1	x_2	x_3	x_4		
1	55	95	50	75	0,89	0,50
2	60	75	70	80	0,39	0,33
3	52	90	52	70	0,79	0,38
4	65	85	50	60	0,57	0,20
5	75	80	45	60	0,20	0,27
6	45	75	60	80	0,55	0,50
7	70	100	55	68	1,00	0,29
8	55	85	50	65	0,67	0,30
9	60	70	62	70	0,25	0,21
10	50	80	45	90	0,60	0,82
11	65	90			0,71	
12	52	80			0,58	
13	55	70			0,33	
Jumlah					7,53	3,80
Rata-rata					0,58	0,38

From Table 7 above, it can be seen that the average N-Gain score of students' mathematical problem solving abilities obtained by problem-based learning model in the experimental class is greater than that of students receiving conventional learning in the control class. This suggests that improving the problem-solving ability of the experimental class math is better than the conventional class. The 0.58-grade N-Gain control grade went into the "moderate" category improvement and the 0.38 experimental class went into the "moderate" category improvement according to N-Gain criteria. CalculationValue of Variance (S^2) and Standard deviation (S) N-Gain Mathematical Problem Solving Score.

Table 8. Calculating Variance Values and Standard Deviation N-Gain Score Mathematical Problem Solving Skill

No	N-Gain Experiment Class	x_1^2 Experiment Class	N-Gain Control Class	x_2^2 Control Class
1	0,89	0,7921	0,50	0,2500
2	0,38	0,1521	0,33	0,1089
3	0,79	0,6241	0,38	0,1444
4	0,57	0,3249	0,20	0,0400
5	0,20	0,0400	0,27	0,0729
6	0,55	0,3025	0,50	0,2500
7	1,00	1	0,29	0,0841
8	0,67	0,4489	0,30	0,0900
9	0,25	0,0625	0,21	0,0441
10	0,60	0,3600	0,82	0,6724
11	0,71	0,5041		
12	0,58	0,3364		
13	0,33	0,1089		
$\sum$	7,53	5,06	3,80	1,76

From the calculation results obtained value of experimental class variance = 0.056 and the standard deviation value of the experimental class = 0.24. The control class variance value = 0.035 and the standard deviation value of control class = 0.19.

4) Normality Test of N-Gain Data Distribution

The data distribution normality test aims to find out whether the data in the form of N-Gain score of mathematical problem solving ability of each group in this study comes from normal distributed population or not. The author uses the Lilliefors Test because the data obtained are not presented in intervals.

Table 9. Normality Test N-Gain Score Ability Mathematical Problem Solving Experiment Class (A)

x_i	f_i	f_{kum}	z_i	Table z	Range z_i	S(z_i)	| zi-S(z_i)|
0,20	1	1	-1,58	0,4429	0,0571	0,0769	0,0198
0,25	1	2	-1,38	0,4162	0,0838	0,1538	0,0700
0,33	1	3	-1,04	0,3508	0,1492	0,2308	0,0816
0,38	1	4	-0,79	0,2852	0,2148	0,3077	0,0929
0,55	1	5	-0,13	0,0517	0,4483	0,3846	0,0637
0,57	1	6	-0,04	0,0160	0,4840	0,4615	0,0225
0,58	1	7	0,00	0,0000	0,5000	0,5384	0,0384
0,60	1	8	0,08	0,0319	0,5319	0,6154	0,0835
0,67	1	9	0,38	0,1480	0,6480	0,6923	0,0443
0,71	1	10	0,54	0,2054	0,7054	0,7692	0,0638
0,79	1	11	0,88	0,3106	0,8106	0,8462	0,0356
0,89	1	12	1,29	0,4015	0,9015	0,9231	0,0216
1,00	1	13	1,75	0,4599	0,9599	1	0,0401

Based on 9, the above data is obtained L_{max} = 0,0929 and Lilliefors tables Range. (L_{table}), L_{table} = $L_{0,05}(n_1\text{-}1)$ = $L_{0,05}(12)$ = 0,242, because $L_{max} < L_{table}$, are 0,0929 < 0,242 then the data is normally distributed.

Table 10. Normality Test N-Gain Score Capability Mathematical Problem Student Control Class (B)

x_i	f_i	f_{kum}	z_i	Table z	z_i	S(z_i)	| zi-S(z_i)|
0,20	1	1	-0,95	0,3285	0,1715	0,1000	0,0715
0,21	1	2	-0,89	0,3133	0,1867	0,2000	0,0133
0,27	1	3	-0,58	0,2190	0,2810	0,3000	0,0190
0,29	1	4	-0,47	0,1808	0,3192	0,4000	0,0808
0,30	1	5	-0,42	0,1628	0,3372	0,5000	0,1628
0,33	1	6	-0,26	0,1026	0,3974	0,6000	0,2026
0,38	1	7	0,00	0,0000	0,5000	0,7000	0,2000
0,50	2	9	0,63	0,2357	0,7357	0,9000	0,1643
0,82	1	10	2,32	0,4898	0,9898	1	0,0102

Based on table 10, L_{max} = 0,2026 and Lilliefors tables Range (L_{table}), L_{table} = $L_{0,05}(n_2\text{-}1)$ = $L_{0,05}(9)$ = 0,271, because $L_{max} < L_{table}$, that are 0.2026 < 0,2710 then the data is normally distributed.

5) Homogeneity Test of N-Gain Data Variance

The homogeneity test was conducted to test the homogeneity of data variance to be analyzed between the experimental class and the control class. According to [7] the pair of hypotheses to be tested in homogeneity testing are as follows:

$H_o: \sigma_1{}^2 = \sigma_2{}^2$ (both variances homogenous)
$H_1: \sigma_1{}^2 \neq \sigma_2{}^2$ (both variances non homogenous)

This test is a two-party test, because it is a study that requires a comparison between two conditions or two populations. Then the test criteria :" H_0 is accepted when $F_{count} < F_{table}$ ($dkn_{highvariances-1}/dkn_{lowvariances-1}$)". Based on the previous calculation, we get the N-gain variance from each group $s_1{}^2$ = 0,056 (experiment group) dan $s_2{}^2$ = 0.035 (control group). To test the homogeneity of samples used equation as follows:

$$F = \frac{\text{Hign Variances}}{\text{Low Variances}}$$
$$F = \frac{0{,}056}{0{,}035}$$
$$F = 1{,}60$$

F from the distribution table obtained:

$F_{0.05}$ ($dkn_{highvariance-1}/dkn_{lowvariance\ kecil-1}$) = $F_{0.05}$ (13-1/10-1) = $F_{0.05}$ (12/9) = 3,07

So F_{count}= 1,60 dan F_{table} = 3,07, it is clear that $F_{count} < F_{table}$ so H_0 accepted and it can be concluded that both groups of data have homogeneous variance.

6) Testing of N-Gain Data Hypothesis

In testing this hypothesis, calculate or compare the two previous calculations. The average value and variance of N-Gain obtained is:

$\bar{x}_1 = 0{,}58$ $s_1^2 = 0.056$ $s_1 = 0{,}24$ $n_1 = 13$
$\bar{x}_2 = 0.38$ $s_2^2 = 0.035$ $s_2 = 0{,}19$ $n_2 = 10$

Using the equation (8) obtained the combined variance (S^2), the combined standard deviation (S) of 0.047 and 0.22, respectively. Furthermore, using equation (7) obtained t value of 2.16. At a significant level α = 0,05 and degrees of independence dk = $n_1 + n_2 - 2 = 21$, so t_{table}= $t_{(1-\alpha)(n_1+n_2-2)}$= $t_{(0,95)(21)}$ = 1,72. Testing criterion H_o is rejected when $t_{count} > t_{Table}$, for other t value H_o is accepted. Based on the above calculation results obtained $t_{count} = 2{,}16$ and t_{Table}= 1,72 or $t_{count} > t_{Table}$. Thus Ho is rejected at a significant level α = 0.05. It can be concluded that the improvement of students' mathematical problem solving skills taught with problem-based learning model is better than the students taught by conventional learning in Applied Mathematics course II in Industrial Engineering Program of Polytechnic of South Aceh.

C. Discussion

Based on the result of data analysis, the average score of N-Gain score of mathematical problem solving ability of the experimental class is 0.58, while the average N-Gain score of mathematical problem solving ability of the control class students is 0.38. The average N-Gain expriment and control classes go into the "moderate" category improvement, but the average N-Gain expriment class is greater than the average N-Gain control class. This value indicates that improving the problem solving ability of the experimental mathematics class is better than the control class. From result of hypothesis testing to N-Gain data, obtained $t_{count} = 2{,}16$ and t_{Tabel}= 1,72 or $t_{count} > t_{Table}$, thus Ho is rejected at a significant level α = 0.05, it can be concluded that the improvement of problem-solving skills taught with problem-based learning model is better than the improvement of problem-solving skills taught by conventional learning.

V. Conclussion and Suggestion

A. Conclussion

It concluded from data analysis conducted that the improvement of problem solving skills of mathematical students taught with problem-based learning model is better than the students taught by conventional learning in the subjects of Applied Mathematics II in the Industrial Engineering Program Polytechnic of South Aceh.

B. Suggestion

Based on the conclusions that have been described, the writer promote the educators to use approaches and models of learning when teaching in the classroom. This can improve student problem-solving skills and enable teaching and learning in the classroom.

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